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WESTERN ATLANTIC *OPHIOLEPIS* (ECHINODERMATA: OPHIUROIDEA): A DESCRIPTION OF *O. PAWSONI* NEW SPECIES, AND A KEY TO THE SPECIES

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ABSTRACT

Ophiolepis pawsoni, a new species of ophiolepidinine brittlestar, is readily distinguished from its congeners by its color pattern. Lines of intense brown pigmentation demarcate white bands on the arms and white patches on the disc from the pale reddish-brown ground color of the body. *O. pawsoni* is part of the deep-reef echinoderm fauna, and occurs sympatrically with *O. gemma* on the seaward slope of the Belize Barrier Reef. Its other western Atlantic congeners *O. elegans, O. impressa, O. kieri,* and *O. paucispina* generally are found in soft bottom habitats and in reef, seagrass, or mangrove, shallow-water communities. *O. ailsae* is restricted to bathyal depths considerably below hermatypic reef formations. These seven species of *Ophiolepis* comprise three groups with contrasting morphologies: (1) taxa with a convex disc, long slender arms, a dispersed central rosette of primary plates and generally with several columns of major scales in the interradial field (*O. ailsae, O. gemma, O. impressa, O. kieri,* and *O. paucispina*); (2) taxa with a flat disc and united central rosette, with arms that are flat, short, and broad near the disc and with a single column of major scales in the interradial field (*O. elegans*), and (3) taxa with small, thick, irregularly arranged disc scales of approximately equal size (*O. pawsoni*).

Using SCUBA, an ichthyocide containing rotenone ("Noxfish") was used to obtain cryptic species living deep within the reef framework of the Belize Barrier Reef. Previously undescribed ophiuroid species were among the specimens taken between 21 and 27 m depth on the forereef slope of Carrie Bow Cay and nearby islands. Two of the new species have previously been described: *Ophioderma ensiferum* Hendler and Miller, and *Ophiolepis gemma* Hendler and Turner. These, and several species yet to be described, constitute part of a distinctive *deep-reef echinoderm fauna.* The deep-reef taxa generally do not occur in waters shoalward of the forereef slope, but they range to depths over 100 m, near the lower bathymetric limits of massive hermatypic coral formations (Hendler and Miller, 1984; Hendler and Turner, 1987; unpub. obs.).

The new species described in this paper was taken at several poison stations. Only two individuals and a few arm fragments were collected, but they are sufficiently distinctive to warrant the description of a new species. They are moderately large ophiuroids and appear to be adult specimens. Their coloration and external skeletal structures are so unusual that there is virtually no possibility of confusion between *O. pawsoni* and other brittlestar species.

SYSTEMATIC ACCOUNT

Family OPHIURIDAE
Subfamily Ophiolepidinae
Genus *Ophiolepis* Müller and Troschel, 1840
Ophiolepis pawsoni, new species
Figures 1, 2

Etymology.—Named for an extraordinary echinodermologist, Dr. David L. Pawson, Curator, U.S. National Museum of Natural History.

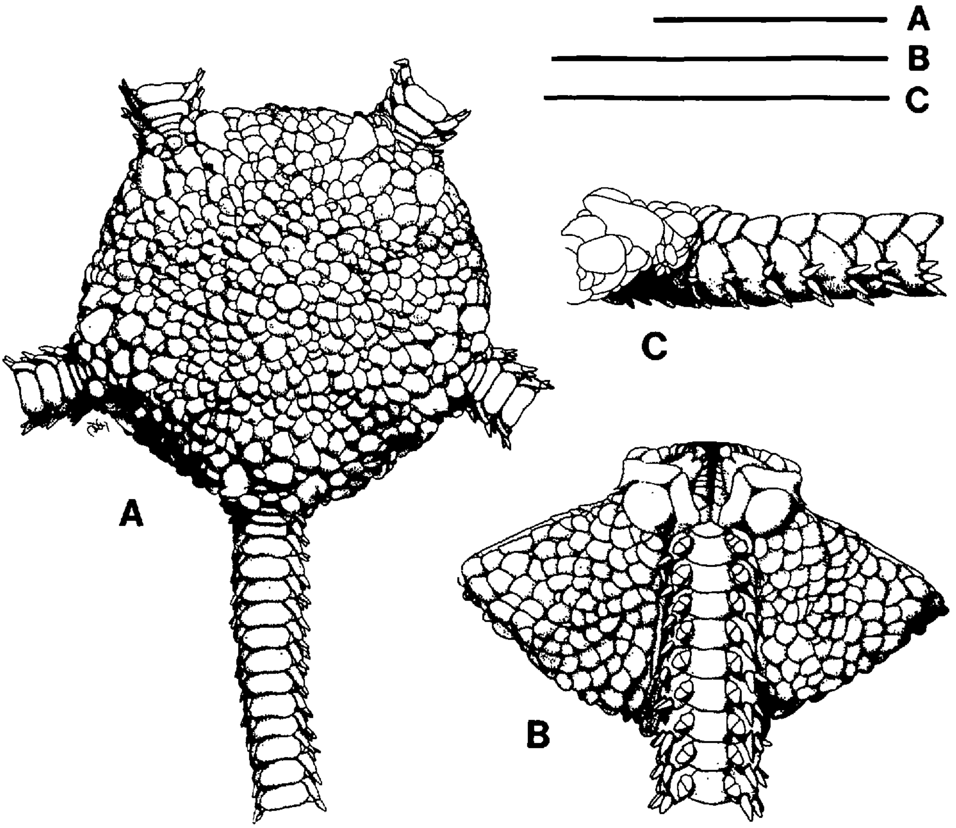

Figure 1. *Ophiolepis pawsoni* new species, holotype, LACM 83-132.3: A, disc and portion of arm, dorsal view; B, portion of disc, ventral view; C, arm base, lateral view. Scale bars for the three elements of the figure equal 10 mm.

Material.—(LACM 83-132.3), dry HOLOTYPE, sta. CBC-83-3, 3 April 1983, ESE of Carrie Bow Cay on the seaward forereef slope of the Belize Barrier Reef, 24.4 m, poison station, SCUBA; (LACM 83-149.1), alcoholic PARATYPE, sta. CBC-83-11, 8 November 1983, ESE of Carrie Bow Cay on the seaward forereef slope of the Belize Barrier Reef, 24.4 m, poison station, SCUBA; (USNM E35125), alcoholic arm fragments, sta. CBC-83-9, 6 November 1983, ENE of Carrie Bow Cay on the seaward forereef slope of the Belize Barrier Reef, 24.4 m, poison station, SCUBA; (LACM 85-164.2), alcoholic arm fragment, sta. CBC-85-5, 14 June 1985, E of South Water Cay on the seaward forereef slope slope of the Belize Barrier Reef, 21.3 m, poison station, SCUBA.

Color photographic slides of the living paratype are deposited in collections of Los Angeles County Museum of Natural History (LACM) and National Museum of Natural History, Smithsonian Institution (USNM).

Diagnosis.—Species of moderate size with gradually tapering arms. Disc diameter: arm length approximately 1:7. Dorsal surface of disc slightly convex; covered with numerous, thick, circular to ovoid scales; few, scattered intercalary scales. Scales similar in size, largest occurring near radial shields. Central rosette not distinctly differentiated from disc scales. Radial shields widely separated. Scales between radial shield and first dorsal arm plate thick, circular. Accessory dorsal arm plates small, present on all segments except distal tip of arm. Most lateral arm plates with 3 spines; length of dorsal spine less than one-half segment, middle spine equals approximately one-half segment, ventral spine exceeds one-half segment. Ground color pale reddish brown; arms with white bands, disc with irregular white patches; white zones demarcated by bordering line of intense brown/red-brown.

Description of Holotype. — Disc diameter 17.1 mm; length of longest arm 108 mm. Disc rounded-pentagonal; dorsal surface rough, slightly convex; much of central region flattened; ventral surface flat. Disc covers proximal seven arm segments. Arms slender, gradually tapering; dorsal surface rounded; ventral surface relatively flat, thick ventral arm plates forming flat medial ridge; arm tip finely tapered, dorso-ventrally flattened.

Disc covered with numerous, thick, round to ovoid scales; largest scales between radial shields; smaller, thin intercalary scales rare, scattered. Central plate diameter 1.2 mm; radial plates similar to disc scales. Central rosette and radiating columns of major scales absent.

Radial shields thick, smooth, irregularly triangular to ovoidal, longer than wide; widely separated. Two or three thick, circular scales between distal edge of radial shield and first dorsal arm plate.

Each jaw with apical oral papilla (a small tooth); each side of jaw with 6 to 8 oral papillae. Distalmost papilla is a buccal tentacle scale; adjacent papilla large, with curved free edge; more proximal papillae smaller, rhomboidal.

Oral shield rounded-pentagonal, about as long as wide; two proximal sides slightly concave; three distal sides convex. Madreporite somewhat longer than wide. Adoral shields with proximal edges in contact; proximolateral and distolateral sides concave; widened distally producing a lobe separating first ventral arm plate and oral plate.

Genital slits extend nearly to edge of disc, bordered by long, narrow genital scale and 3–4 smaller scales proximad. Ventral interbrachial field covered with numerous, tumid scales of nearly equal size, with very few small, thin intercalary scales.

Proximal dorsal arm plates more than twice as wide as long; proximal and distal edges parallel, lateral edges diverging; distolateral edge curving anteriad. Dorsal arm plates in contact for approximately 90% of arm length (128 of 149 segments). Distal plates narrower, becoming nearly triangular at arm tip. Accessory dorsal arm plates small; two associated with each dorsal arm plate for approximately 90% of arm length (117 of 149 segments), rarely divided into two small plates.

Lateral arm plate in dorsal view with distal edge slightly flared. Arm spines small, laterally compressed, acutely narrowing to a blunt tip; base of spine thick. Dorsalmost spine less than one-half segment length; middle spine approximately one-half segment length; ventralmost spine usually greater than one-half segment length. At base of arm, one spine on each lateral arm plate between segments 1–6; 2 spines between segments 5–6; 3 spines beginning at segment 5–7, continuing for 140 segments (approximately 90% of arm length); distal segments with 2, 1, then 0 spines. Dorsalmost spine on distal tenth of arm (final 10–15 segments) with minute, glassy terminal hook (beginning on segment numbers 134 and 136 of longest arm); hooked spines often with secondary barb.

Ventral arm plates in contact along approximately 90% of arm length (140 of 149 segments). Plates beneath disc wider than long, flat; proximal and lateral edges concave, distal edge convex. Distal plates distinctly longer than wide, those on distal half of arm constricted mid-laterally.

Two (rarely three) semicircular tentacle scales attached to lateral arm plate form ovoid operculum over each tentacle pore; length of operculum equals approximately ⅔ length of ventral arm plate. Operculum covers one to four minuscule tentacle scales attached to ventral arm plate. Tentacle scales diminish in size distally; near arm tip abradial scale ovoid, adradial scale absent. Tube feet of live individuals thick, with plicate shaft; tips bulbous.

Color of holotype and preserved specimens: Ground color of dorsal surface pale grayish red-brown; arms with white bands, disc with irregular white patches; bordering line of intense red-brown demarcates white and red-brown regions. Ventral surface whitish, some small patches of red-brown beneath disc and on lateral arm plates.

Pigmentation, particularly the red coloration, of living individuals similar, but more intense than in dried or alcoholic specimens. In living specimens examined microscopically, arm plates have thin whitish border; arm spines of darkly pigmented arm segments stippled with red-brown pigment; tips of tube feet sometimes rose colored.

Variation.—The paratype is smaller than the holotype, its disc diameter 14.7 mm, and maximum arm length 96 mm. Disc diameter: arm length is approximately 1:6.5 (all arms, including the longest are broken and regenerating). General form and scalation of disc and arms are similar to the holotype, with the following exceptions.

Neither central nor radial plates are differentiated. Side of each jaw with only 4 or 5 oral papillae and buccal tentacle scale. Lateral sides of oral shields are straight and somewhat diverging proximally. A single hydropore is visible on the madreporite.

The longest arm is composed of 147 segments, and the proximal 6 to 7 segments are covered by the disc. The dorsal and ventral arm plates are in contact for about 90% of the arm length (dorsal arm plates for 113 segments, ventral arm plates for 136 segments). Segments of approximately 80% of the arm length (89 segments) have accessory dorsal arm plates. There is a single spine on each of the lateral arm plates of segments 1–4; 2 spines on segments 4–6; 3 spines on subsequent segments for approximately 90% of arm length; then 2, 1, and 0 spines on the terminal segments. Thus, most lateral arm plates have 3 arm spines, but among the segments with 3 spines on each side of the longest arm there are exceptional segments with 1, 2, or 4 spines. Similarly, in the holotype a few arm segments bear 2 or 4 spines. Beginning with segment 126 the dorsal arm spines are hooked.

Color of the paratype is similar to that of the holotype except that some of the ventral arm plates have dark pigmented flecks of microscopic size.

Distribution.—Known only from the seaward slope of the Belize Barrier Reef off the islands of Carrie Bow Cay and South Water Cay, Belize, at depths between 21.3 and 24.4 m.

Biology.—*Ophiolepis pawsoni* was collected on the steep forereef wall. Descriptions of the habitat are provided in Rützler and MacIntyre (1982) and Hendler and Miller (1984). At poison stations, individuals emerged from reef structures adjacent to mounds of the coral *Montastrea annularis* (Ellis and Solander), large sponges, gorgonians, and coral rubble. They were taken only where application of ichthyocide solution was particularly effective and never at similar sites where superficial corals and algae were excavated without applying ichthyocide. Therefore, I presume that *O. pawsoni* lives within the reef framework and responds to "Noxfish." Where the specimens of *O. pawsoni* were collected, other ophiuroids were taken in relatively large numbers, such as *Ophioderma rubicundum* Lütken, *Ophiocoma paucigranulata* Devaney, *Ophionereis olivacea* H. L. Clark and *Ophi-*

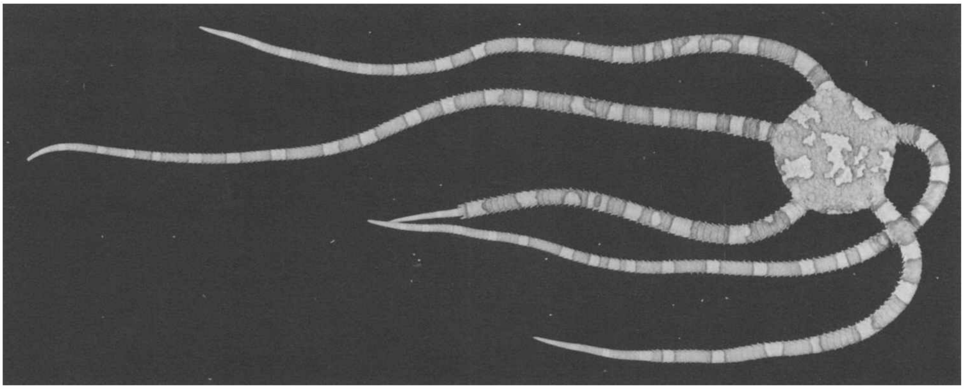

Figure 2. *Ophiolepis pawsoni* new species, holotype, LACM 83-132.8. Photograph of the dorsal surface showing the characteristic color pattern. The ground color of the body is pale reddish-brown; white patches on the disc and bands on the arms are bordered by intense brown pigmentation.

urochaeta species. On the forereef, *Ophiolepis gemma* was considerably more common than *O. impressa* Lütken, and *O. pawsoni* was rare.

I suggest that since the specimens of *O. pawsoni* are large and robust (larger than most sympatric congeners) the type locality probably is a suitable (rather than marginal) habitat for the species. It is not yet known whether its population density is low, or if some individuals of *O. pawsoni* deep in the reef wall do not emerge at the poison stations. It is interesting that all the arms of both specimens of *O. pawsoni* had regenerated one or more times (Fig. 2), indicating that there is probably predation on the species at the collecting site.

KEY TO THE WESTERN ATLANTIC SPECIES OF *OPHIOLEPIS*

1a. Dorsal surface of the disc with large scales completely or incompletely encircled by numerous small intercalary scales (Fig. 3a, b). Central and radial plates comprise a distinct central rosette (Fig. 3a, b). Color not as in 1b 2

1b. Dorsal surface of the disc with very numerous, thick scales of moderate size and fewer small, scattered intercalary scales. Central rosette not distinct (Fig. 1a). Overall color, pale reddish-brown; very conspicuous white bands on arms and white patches on disc bordered with intense reddish-brown (Fig. 2) .... *O. pawsoni,* new species

2a. Dorsal surface of disc with three or more columns of major scales in each interradial field. Disc convex, rough (Fig. 3a) 3

2b. Dorsal surface of disc with a single column of major scales in each interradial field. Disc flat, smooth; 2–3 swollen scales on the disc edge between arm bases (Fig. 3b). Usually 4–6 arm spines .... *O. elegans* Lütken

3a. Two or four spines on lateral arm plates of most arm segments 4

3b. Three spines on lateral arm plates of most arm segments 5

4a. Two spines on most lateral arm plates beyond the disc. Continuous row of small intercalary scales borders major disc scales (Fig. 3b). Arm segments with accessory dorsal arm plates except near the tip .... *O. paucispina* (Say)

4b. Four arm spines (rarely five) on most lateral arm plates beyond the disc. Arrangement of intercalary scales discontinuous (Fig. 3a). Accessory dorsal arm plates small, present only on proximal ½ to ¾ of arm (or less in small specimens) .... *O. impressa* Lütken

5a. Major disc scales thickened or tumid. Arm tips blunt, tapering abruptly, and markedly dorsoventrally flattened. Terminal arm segments wider than long 6

5b. Major dorsal disc scales thin, often polygonal. Edges of the scales of wet specimens reflect light and appear whitish. Arm tips slender, tapering gradually. Terminal arm segments longer than wide. Radial shields smooth, flat .... *O. gemma* Hendler and Turner

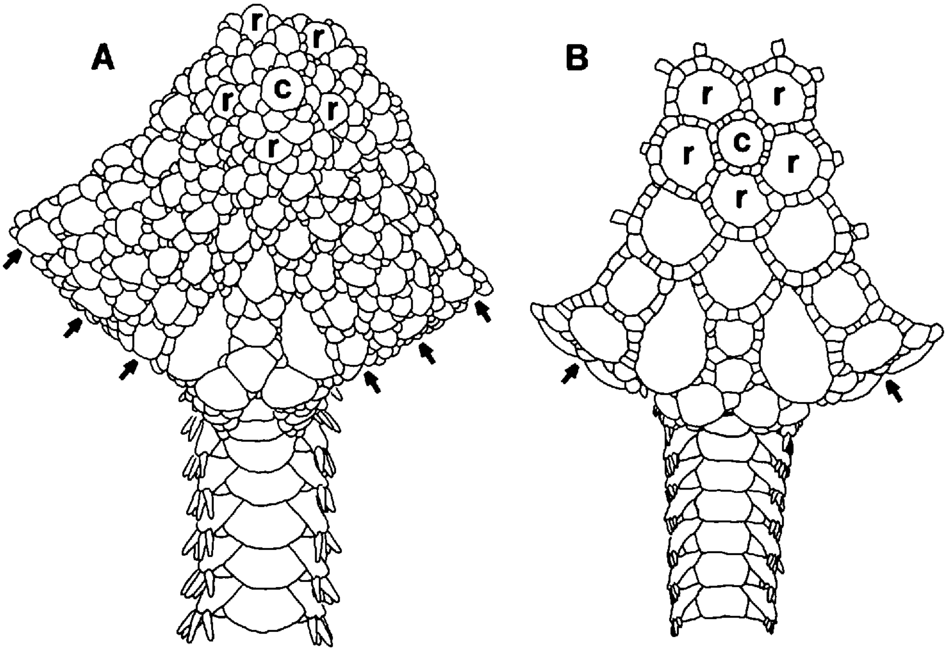

Figure 3. *Ophiolepis impressa* (A) compared with *Ophiolepis elegans* (B) to illustrate diagnostic features cited in the key to the species. The central plate (c) and five radial plates (r) comprise a "rosette" on the dorsal surface of the disc of both species. Arrows (→) indicate columns of major scales in the interradial field. *Ophiolepis impressa* has irregular rows of intercalary scales around the major disc scales; in *O. elegans* the intercalary scale rows are regular and continuous.

6a. Central plate encircled by intercalary scales. Radial shield smooth, tumid. Occurs in deep water, 156–549 m .... *O. ailsae* Hendler and Turner
6b. Central plate in contact with portions of the proximal edge of radial plates. Radial shield surface slightly concave and rough, with microscopic bumps and pits. Occurs in shallow water, <10 m .... *O. kieri* Hendler

DISCUSSION

Distribution.—*Ophiolepis pawsoni* is a component of the Caribbean deep-reef echinoderm fauna. Similarly to *Ophioderma ensiferum, Ophiolepis gemma,* and other ophiuroid species yet to be described, it appears to occur exclusively on the steep reef wall. Assuming that *O. pawsoni* is distributed as other members of the deep-reef fauna, it probably is absent on the shoal regions of reefs but occurs in deeper water, at least to the bathymetric limit of hermatypic coral growth, and it may be widespread in the Caribbean.

Ophiolepis pawsoni has been collected at the same stations as two congeners, *O. gemma* and *O. impressa.* The zone of overlap is near the upper end of the bathymetric range for *O. gemma* (Hendler and Turner, 1987). This is probably near the lower end of the bathymetric range of *O. impressa,* a species found abundantly on shallow reefs (Hendler and Turner, 1987).

Systematic Relationships.—A unique color pattern distinguishes *O. pawsoni* from its western Atlantic congeners (Fig. 2). It differs sufficiently in dorsal disc scalation from other *Ophiolepis,* that its generic assignment might be questioned. Most

Ophiolepis species have a prominent "rosette" (Fig. 3a, b) composed of the central and radial plates (the "primary" or "primitive" plates of the dorsal surface of the disc). They also have major (large) disc scales arrayed in columns radiating from the rosette, and small intercalary scales encircling the large plates and major scales (Fig. 3a, b).

The irregularly arranged, thick plates of nearly uniform size and relatively small, widely separated radial shields give the disc of *O. pawsoni* an aspect similar to that of another ophiolepidinine, *Ophioplocus januarii* (Lütken) (illustration in Thomas, 1975). However *O. pawsoni* is clearly not referable to *Ophioplocus* Lyman as redefined by Thomas, 1975, and with the removal of the genus *Ophioceres* as suggested by observations in Baker and Devaney, 1981. *Ophiolepis pawsoni* lacks features that distinguish *Ophioplocus,* such as papilliform genital scales, fragmented dorsal arm plates, and short genital slits.

The new species is referred to the genus *Ophiolepis* for the following reasons. It has a mixture of large disc scales and small intercalary scales, though the latter are few and scattered. Its radial shields have associated distal plates (structures referred to as "accessory radial shields" in Hendler and Turner, 1987; "ear-like plates" in Baker, 1979) that are characteristic of the genus, though these plates in *O. pawsoni* are relatively small and irregularly positioned. The structure of its oral frame and genital slits is typical of most *Ophiolepis* species, as is the arm structure. For example, associated with each tentacle pore, *O. pawsoni* has paired operculiform tentacle scales on the lateral arm plate and minute opposing scales on the ventral arm plate. Also typical for the genus are the shape of its arm, and the presence of paired accessory dorsal arm plates and hooked dorsal arm spines.

Variations in the taxonomic features noted above point to the need for a re-examination of the relationships of *Ophiolepis* species within the context of the subfamily Ophiolepidinae. For instance, *Ophiozona* Lyman (sensu Matsumoto, 1917) was synonymized with *Ophiolepis* based on the discovery of accessory dorsal arm plates in species of *Ophiozona* (Devaney, 1974). However, the value of accessory dorsal arm plates as a synapomorphy for *Ophiolepis* species is called into question by the variable expression of accessory dorsal arm plates within and between the different species. For example, *Ophiolepis paucispina,* a small species, consistently has accessory plates along the whole length of arm, although larger individuals have more numerous and conspicuous accessory dorsal arm plates than small individuals. In contrast, adults of similar size *O. gemma* may have only a few basal arm segments with any accessory plates, and the accessory dorsal arm plates are barely discernible or absent in juveniles.

The recognized distinction between *Ophiolepis* and *Ophiotylos* Murakami, a related genus of very small species, is based on the absence of accessory dorsal arm plates and the presence of one (rather than two) tentacle scales in the latter taxon. However, these two variable features do not provide a convincing basis for distinguishing genera within the Ophiolepidinae. The variability in development of the accessory dorsal arm plates has been noted above, and the variability of tentacle scale number within ophiolepidinine genera is well documented (Matsumoto, 1917). The overlap, and possible homoplasy, of important characters used to define *Ophiolepis* and related genera (e.g., *Ophiozonoida* H. L. Clark, *Ophioplocus* Lyman, *Ophioceres* Koehler, and *Ophiolebella,* Mortensen) point to a need for clarification of the systematic significance of ophiolepidinine taxonomic characters.

In light of these observations, I must revise the suggestion (Hendler, 1979) that related groups within the genus *Ophiolepis* can be recognized solely on the basis of intercalary scale arrangement and the development of accessory dorsal arm plates. However, an examination of the western Atlantic species of *Ophiolepis* suggests three groups within the genus. Within one group are species with convex discs, and narrow, rounded, gradually tapered arms such as *O. ailsae, O. gemma, O. impressa, O. kieri, O. paucispina,* and Pacific taxa such as *O. superba* H. L. Clark and *O. cincta* (Müller and Troschel). Members of this group have several columns of major scales in the dorsal interradial field of the disc and major scales continue to accrue to the interradial columns during ontogenesis. In a second group, including *O. elegans* and eastern Pacific taxa such as *O. variegata* Lütken and *O. crassa* Nielsen, the arms are flat, short, very broad near the disc and thereafter tapering abruptly towards the tip. In *O. elegans* and *O. variegata* there is only a single column of major scales in the interradial field, and the number of major scales on the dorsal surface of the disc is fixed at an early ontogenetic stage. However, *O. crassa* has adult disc scalation and an ontogenetic pattern similar to species in the first group. In a third group, to which *O. pawsoni* belongs, the major disc scales are irregularly arranged, and a rosette of primary plates and radially arranged columns of scales are absent.

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